Animism, Aristotelianism, and the Legacy of William Gilbert's *De Magnete*

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William Gilbert's 1600 book, De magnete*, greatly influenced early modern natural philosophy. The book describes an impressive array of physical experiments, but it also advances a metaphysical view at odds with the soon to emerge mechanical philosophy. That view was animism. I distinguish two kinds of animism – Aristotelian and Platonic – and argue that Gilbert was an Aristotelian animist. Taking Robert Boyle as an example, I then show that early modern arguments against animism were often effective only against Platonic animism. In fact, unacknowledged traces of Aristotelian animism can be found in Boyle's mechanical account of nature. This was Gilbert's legacy.*

1. Introduction: Magnetic Philosophy and Mechanical Philosophy

In *The Man in the Moone*, a fictional travelogue written by the Anglican bishop Francis Godwin (1562–1633) and published in 1638, the Spanish protagonist Domingo Gonsales tethers a gaggle of geese into an elaborate flying contraption, and together they take to the skies. Indeed, they journey all the way to the moon. En route, Gonsales witnesses two incredible things. First, as he tells us, once aloft, the geese,

> to my unspeakable feare and amazement strooke bolt upright, and never did linne towring upward, and still upward, for the space, as I might guesse, of one whole hower; Toward the end of which time, mee thought I might perceive them to labour lesse and lesse; till at length, O incredible thing, they forbare moving any thing at all and yet remained unmoveable, as stedfastly, as if they had beene upon so many perches; the Lines slacked; neither I, nor the Engine moved at all, but abode still as having no manner of weight. (Godwin 1638, p. 46)

Having swiftly ascended high above the Earth, Gonsales, geese, and flying machine achieve a sudden and unexpected state of weightlessness. Gonsales,

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who is clearly an avid student of natural philosophy and a determined advocate of observation, draws the following startling conclusion.

> I found then by the Experience that which no Philosopher ever dreamed of, to wit, that those things which wee call heavie, do not sinke toward the Center of the Earth, as their naturall place, but as drawen by a secret property of the Globe of the Earth, or rather some thing within the same, in like sort as the Loadstone draweth Iron, being within the compasse of the beames attractive. (Godwin 1638, pp. 46–7)

This is a sweeping broadside against the timeworn conventions of Aristotelian natural philosophy. Earthly objects do not possess an intrinsic weight, or heaviness, by which they move toward their natural place at the Earth's center. Instead, they move in respect of the Earth as a piece of iron moves in respect of a loadstone, or magnet. Objects departing from the Earth will eventually pass beyond the Earth's observed scope of influence, just as a piece of iron, when withdrawn from a magnet, passes beyond the latter's observed scope of influence.

Gonsales witnesses a second incredible thing while drifting weightlessly between Earth and moon. As he peers down past the clouds to the Earth's surface below, his eyes give him reason to endorse a claim of Copernicus (1473–1543), namely, that

> the Earth according to her naturall motion, (for that such a motion she hath, I am now constrained to joyne in opinion with *Copernicus*,) turneth round upon her owne Axe every 24. howers from the *West* unto the *East* [...]. So that it seemed unto me no other then a huge Mathematicall Globe, leasurely turned before me, wherein successively, all the Countries of our earthly world within the compass of 24 howers were represented to my sight. (Godwin 1638, pp. 56–8)

With this extraordinary observation, Gonsales rejects yet another timeworn Aristotelian conviction—that the Earth is static—and confirms Copernicus's conjecture that the Earth revolves around its own axis. Furthermore, this rotation exhibits a strict regularity, completing one revolution every 24 hours.

These two ideas—that the Earth is a magnet, and that it turns with regularity on its axis—were also central to William Gilbert's book of natural philosophy, *De magnete*, which was published in 1600. Indeed, Gilbert (1540–1603) used the Earth's magnetism to explain its regular diurnal rotation (Henry 2001, p. 107; Georgescu 2017, pp. 169–70). In doing so, he claimed to have proven Copernicus's earlier, and in Gilbert's day still controversial, conjecture that the Earth turns about its own axis. He presented this as an empirical proof, based on a series of disciplined physical experiments with magnets.

It is no surprise that Gilbert's book of experiments and natural philosophy, *De magnete*, influenced Godwin's fantastic travelogue, *The Man in the Moone*.

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Indeed, as Francis Johnson observes, "[a]ll the cosmological ideas presented in *The Man in the Moone* are [...] unmistakably derived from the *De Magnete*." More generally, "[t]he cosmological sections of Gilbert's *De Magnete* exercised a profound influence upon Englishmen interested in science" (Johnson 1968, pp. 234, 231). Jim Bennett likewise writes of the seventeenth century that, "[a]lthough the Royal Society later adopted Francis Bacon as official methodologist, natural philosophers in the first half of the century were more likely to look back to Gilbert as the founder of the experimental method" (Bennett 1981, p. 166; see also Jones 1961, p. 79). Richard Jones furthermore suggests that "the line of scientific development in which the modern spirit is most clearly revealed traces its source not to Bacon but to William Gilbert" (Jones 1961, p. 62).

Yet, recent scholarship sometimes still neglects Gilbert's legacy. For example, in his 2013 book, *The Aristotelian Tradition and the Rise of British Empiricism*, Marco Sgarbi passes over Gilbert, instead crediting Bacon with having "made explicit" the experimentalism implicit in the empirical method of Renaissance Aristotelians. Bacon's well-known "programmatic" "struggle against Aristotelianism" was, Sgarbi argues, nonetheless belied by his "latent Aristotelianism" (Sgarbi 2013, pp. 179, 167, 197). The case for Gilbert influence is, in contrast, more straightforward. Not only was Gilbert an accomplished experimenter—"*De Magnete* was the first great experimental book" (Pumfrey 2002, p. 103)—Gilbert's debt to key Aristotelian ideas – above all the mutual dependency of matter and form—was both stronger and more explicit than Bacon's.[1]

Bennett argues that the later magnetic cosmology inspired by Gilbert pulled at one end of a productive tension peculiar to English seventeenth-century natural philosophy. Pulling at the other end was Continental mechanical philosophy. At issue was an idea of action at a distance, as when iron and magnet move towards one another across space. According to Bennett, Gilbert viewed the "attractive virtue" of magnetism as a "cosmic force [...] regulating motions within the Solar System, [...] a very pure example of action at a distance." Yet, as Bennett also notes, "[a] purely mechanical philosophy would not admit the concept of attractive virtue in any form" (Bennett 1981, pp. 166, 169).[2]

1. Sgarbi elsewhere mentions Gilbert in passing, but only to then slot him into an "anti-Aristotelian paradigm" in the history of science (Sgarbi 2017a, p. 332). David Wootton writes, somewhat provocatively, that "Bacon [...] had very bad judgement when it came to good science, dismissing [...] Gilbert out of hand" (Wootton 2016, p. 107). For more on the relationship between Gilbert and Bacon, see Boas 1951; Roller 1953; Kelly 1963; 1965: chp. 5; and Wang 2016.

2. As we will see in the next section, Gilbert did not define magnetism in terms of "attraction," nor did he view it as a "cosmic force." Gilbert writes of "coition" rather than of "attraction," and he limits magnetic virtue to the region, or "globe," of the Earth. Other celestial globes are governed by their own unique virtues. This point is made more difficult to

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This tension between magnetism and mechanism was, Bennett writes, exemplified by Walter Charleton's 1654 book, *Physiologia Epicuro-Gassendo-Charltoniana*, which reworks for an English audience the mechanical atomism of the French natural philosopher and priest Pierre Gassendi (1592–1655): "There coexist in Charleton both unequivocal affirmation of attraction and the notion of some kind of mechanical explanation" (Bennett 1981, p. 170). Bennett furthermore observes that Gilbert's magnetism influenced Christopher Wren and Robert Hooke in the late 1650s and the 1660s, and thus forms "part of the explanatory background to the emergence of the Newtonian theory in the 1680s" (Bennett 1981, p. 176).

But interest in *De magnete* was not limited to England, and so a neat distinction between English magnetism and Continental mechanism cannot be maintained. Indeed, the tension Bennett notes was present both in England and on the Continent.

Alexandre Koyré has noted the influence of Gilbert's *De magnete* on Gassendi (Koyré [1939] 1978, p. 116 n60). Yet, according to Koyré, Gassendi also sought to transform Gilbert's concept of magnetism, rejigging it into "a force not directed towards its object" (Koyré [1939] 1978, p. 79; also p. 111). The implication is that Gilbert's magnetic philosophy involved a principle of directedness, which he construed as a force or power inherent in the magnet, a power that directs the magnet towards an object. As we will see, while it is true that Gilbert saw in magnetism an inherent power of directedness, for him this did not entail a further claim that the magnet deliberatively chooses its attractant as an object of attention. Indeed, like Aristotle, Gilbert could allow for a soul that does not exercise rational deliberation. The suggestion that Gilbert attributed deliberative consciousness to magnets is the usual ground for labelling him an "animist." In what follows, I will argue that Gilbert was indeed an animist, but that his animism did not include the attribution of deliberation to magnets. Gilbert's animism was what I will call an "Aristotelian animism," and I will contrast this with a "Platonic animism" that ascribes rational deliberation to ostensibly inanimate entities.

For now, let us focus on Gassendi's refusal to accept magnetism as a directive power internal to the magnet. As Bennett notes, one key consideration in this refusal was the prospect of action at a distance. It seemed on Gilbert's account that a magnet could, on the basis of its own internal power, move objects from across space, that it could govern or direct them from a distance.

grasp by Gilbert's self-acknowledged tendency to slip back from talk of coition into talk of attraction (see note 16). There is a long history of misreading Gilbert as assimilating gravitational attraction to magnetism, a history that, Hesse writes, "seems to go back to Bacon" (Hesse 1960, p. 138n2; see also Wang 2016, p. 711). In *The New Organon*, Bacon refers to "Gilbert's opinion [...] that the magnetic force of the earth to attract heavy objects does not extend beyond the circle of its own power" (Bacon [1620] 2000, p. 155).

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As Margaret Osler writes, when Gassendi laid out the principles of his mechanical philosophy, he "consistently ruled out action-at-a-distance as well as any kind of innate activity in matter" (Osler 2001a, p. 430). The two—action-at-distance and innate activity—were related. Under the mechanical philosophy, natural action requires physical contact—one bit of matter immediately abutting another. Hence, like Descartes, Gassendi sought to explain a magnet's apparent reach across space in purely physical terms, as an instance of contact-causation. To this end, he posited the existence of microscopic particles that travelled between the magnet and its attractant. Yet, as Koyré notes, these "little strings, little chains, hooks, the action of particles, [...] are quite unable to do the job that Gassendi assigns to them" (Koyré 1978, p. 248). Indeed, as Osler likewise argues, Gassendi's attempt to give a natural philosophical explanation for directedness in nature jarred against his commitment to pure mechanism. In his account of electrical attraction, for example, Gassendi "did not explain what causes the little cords to reel back in, pulling the straw to the amber." Yet the directedness of this motion, she suggests, "implies the existence of some kind of activity [...], it goes beyond the bounds of purely mechanical principles" (Osler 2001a, p. 434). From this, Osler concludes that Gassendi—"perhaps unwittingly"—"introduced elements of animism into his atomism" (Osler 2001a, p. 439; Osler 2000, p. 203).[3]

As we will see in the case of Robert Boyle (1627–1691), these "unwitting" elements of animism also persisted in seventeenth-century English mechanical philosophy, and so formed part of the magnetic legacy that Bennett traces from Gilbert to Newton. The idea that there was a residual animism running through early modern mechanical philosophy is not new. Fifty years ago, Richard Westfall wrote that "[t]hroughout the seventeenth century, mechanistic modes of expression disguised the survival of animistic modes of thought from earlier philosophies of nature" (Westfall 1971, p. 391).[4] Gilbert's magnetic philosophy was one important line along which animism travelled into early modern mechanism. Once there, it helped natural philosophers to account for a directedness in observed natural phenomena that seemed to resist reduction to pure mechanism. In what follows, I will treat this link between

3. Henry argues that the magnetic philosophy inspired by Gilbert, Bacon, and Kepler was an "intellectual site where actions at a distance were considered in an implicit way, if not openly discussed," and he concludes that Newton's *Principia* may be viewed "as the culmination of the tradition in English natural philosophy which began with Bacon and Gilbert, and which took the possibility of actions at a distance as a given" (Henry 2019, pp. 4, 5). Yet, he endnotes the latter statement with this seemingly incongruous claim: "Strictly speaking, Gilbert did not believe in *actio in distans* [...]. See Wang 2016" (Henry 2019, p. 31). I address Wang's argument later, in note 19.

4. That animism is a "survival" from an older, more primitive culture was an idea introduced by Victorian anthropologist Edward Burnett Tylor (Tylor 1871; cf. Hodgen 1931, Ratnapalan 2008).

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animism and directedness as a link between animism and natural teleology, that is, the idea that some natural movements are directed or governed by immanent ends. Aristotelian animism frames this idea in terms of Aristotle's notion of *entelecheia*, that is, the possession of an immanent final cause or *telos*. In ascribing soul to magnets, Gilbert explicitly draws on Aristotle's notion of *entelecheia*. Hence, when Osler writes that "Boyle [...] appealed to immanent finality, albeit unwittingly and contrary to his own stated intentions," she is picking out the thread of Aristotelian animism that Boyle inherited from Gilbert (Osler 2001b, p. 166). This residual animism, as we will see, persisted in the concept of the "spring of the air," which held a central place in Boyle's experimental practice.[5]

In tracing the silent absorption of Gilbert's magnetic animism into early modern natural philosophy, it is worth noting Koyré's observation that the core issue was not the failure of mechanists to answer the question of magnetism, but their success in reframing the question itself. For Gassendi, whether or not this question can be finally answered in purely mechanical terms, any legitimate answer must view magnetism as an *external* force (Koyré 1978, p. 248). Hence, Gilbert's own appeal to an *internal* directive power was ruled out of court. I hope to show that one significant reason for this was, in Boyle's case, religious or theological.

As Christia Mercer notes, the natural philosopher Jean Baptiste du Hamel (1624–1706), writing in the latter half of the seventeenth century, gave careful and sympathetic attention to the mechanical philosophies of Descartes and Gassendi. Nevertheless, du Hamel insisted that their mechanical explanations failed to "convey the physical principles beneath" (Mercer 1993, p. 58). Yet it was the very existence of such physical principles—as legitimate objects of natural philosophical attention—that was at issue. For an Aristotelian like du Hamel, the principles that gave order and direction to natural processes were necessarily physical ones, that is, irreducibly internal components of the natural realm itself. Gassendi, in contrast, rejected the internal natural principles of Aristotelianism as a threat to piety. Rather than trying to modernise Aristotelianism, as du Hamel set out to do, Gassendi sought instead to entirely replace it with a natural philosophy that he considered more Christian. This "more Christian" philosophy was the pre-Christian atomic materialism of Epicurus (Martin 2014, p. 139ff). The point to emphasise here is the failure of Epicurean atomism to explain the directedness of natural processes. This was du Hamel's complaint. And it was also a complaint laid against the atomists by Aristotle himself: "[T]hey say there is always movement. But why and what this movement is they do not say, nor, if the world moves in this way or that,

5. Several other historians have also emphasised a residual animism in Boyle's mechanical philosophy (Henry 1986; Clericuzio 1990; Anstey 2002).

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do they tell us the cause of its doing so" (Aristotle 1941a, p. 878 [*Metaphysics* 7:6 1071b34-36]; see also Lewis 1988, p. 83, and Furley 1996, p. 77).

For Christian natural philosophers of the seventeenth century, like Descartes, Gassendi, and Boyle, this failure of atomism was precisely its value for Christian piety. Yes, the mechanists' physical descriptions of matter in motion do not account for the governing power that lends order and direction to that movement. But that is because this power is not internal to the natural realm. It belongs instead to a supernatural realm that is external to nature as such. It belongs, in short, to God, and hence it is more legitimately treated as an object of theological attention. As John Henry has argued, for Gassendi the very fact of orderly motion in nature proved the existence of a supernatural deity (Henry 1997, p. 75). The idea of a governing power internal to nature was thus rejected on grounds of piety. This is the nub of the difference between Gilbert, on the one hand, and Descartes, Gassendi, and Boyle, on the other. Yet the theological commitments of the mechanists could prove difficult to maintain in practice. As just noted, some historians have detected an implicit animism that seems to have seeped back into the natural philosophies of both Gassendi and Boyle.

Accepting, on the basis of observation, that natural processes are governed by regularity, the question becomes "What is the source of this governing power?" Contrasting Gilbert with the mechanists, the basic explanatory difference is between a source that is internal and one that is external to nature taken as a whole. I will cash out this explanatory contrast in teleological terms, as a difference in conceptions of final causality (see also Kochan forthcoming). Gilbert's magnetic philosophy was underpinned by his explicit commitment to the idea that nature is governed by its own internal principles, that is, by a natural teleology.

Gilbert's animism was rooted in this natural teleology. Where natural teleology ascribes a power of self-government to nature in general, animism is the particular ascription of self-government to specific natural bodies. Animism is thus a special case of natural teleology. Gilbert viewed the magnet as animate because the directive power of magnetism was, for him, internal to the magnet itself, not just to the natural realm in general. In addition to being governed by a power that operates from within nature—a power that could be unevenly distributed across the natural realm so as to exclude the magnet—the magnet is also, more specifically, governed by its own internal natural power, a power that operates from within its own body. For Gilbert, the magnet, at least in significant part, moves and governs itself.[6] Seventeenth-century mechanical

6. This distinction already appears in Aristotle. In *Physics* 8:4, he addresses cases of natural movement in which "difficulty would be experienced in deciding whence the motion is derived, e.g. in the case of light and heavy things. When these things [...] are in motion to their proper positions—the light thing up and the heavy thing down—their motion is

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philosophers, in contrast, explicitly rejected natural teleology, in general, and so animism, in particular. For Descartes, Gassendi, and Boyle, the power that governs nature must itself be external to nature.

As we have seen, when Gonsales and his gaggle of geese had achieved a state of weightlessness high above the Earth's surface, Gonsales concludes that terrestrial things are heavy because they are "drawen by a secret property of the Globe of the Earth, or rather some thing within the same, in like sort as the Loadstone draweth Iron, being within the compasse of the beames attractive." Godwin's protagonist thus follows Gilbert in viewing the power of terrestrial gravity as operating from within the Earth itself (though Gilbert did not treat gravity as magnetic—see note 2). Furthermore, Godwin ascribes strict spatial limits to the distance over which the Earth's objects are governed. Once Gonsales and his geese have escaped the "compasse of the beames attractive," their movements are no longer within the Earth's scope of power. Hence, as we will see, Gilbert's magnetic philosophy is compatible with a *regional* conception of governmental power. For Gilbert, different regions of the cosmos are governed by different powers. For strict mechanists like Descartes, Gassendi, and Boyle, by contrast, the cosmos is a single, uniform entity, governed from without by a single and supernatural, uniform source. Christian mechanism is thus compatible with a *universal* conception of governmental power.

With this rough sketch now in place, let us delve into the details of Gilbert's magnetic philosophy. Historians have presented conflicting views on the nature of his animism. So, what kind of animist was Gilbert?

2. Two Kinds of Early Modern Animism: Aristotelian and Platonic

Was Gilbert even an animist? A few historians have said no.[7] A significantly greater number, however, have said yes.[8] As we will see, there is ample evidence to support the majority position. So let us accept the view that Gilbert was an animist, and move on to a trickier question: "What kind of animist was Gilbert?"

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natural; but in this latter case it is no longer evident [. . .] whence their motion is derived. It is impossible to say that their motion is derived from themselves: this is a characteristic of life and peculiar to living things" (Aristotle 1941b, p. 364 [255^{a}2-7]). Hence, a natural entity might not move itself yet still be moved by nature. Insofar as this movement is regular, it is a case of natural teleology but not of animism.

7. See: Chalmers 1937, p. 75; Agassi 1958, p. 240; Strong 1966, pp. 165, 167; Heilbron 1979, p. 29. Agassi refers to "the widespread myth of Gilbert's animism." Strong suggests that Kepler abandoned animism after reading Gilbert.

8. See: Zilsel 1941, *passim*; Roller 1959, p. 153; Hesse 1960, p. 136; Jones 1961, p. 20; Kelly 1965, p. 103; Abromitis 1977, pp. 27, 97, 126; Koyré 1978, pp. 116n58, 187, 227; Bennett 1981, p. 166; Baldwin 1985, p. 157; Henry 1997, p. 49; 2001, *passim*; 2012, p. 96; Georgescu 2017, p. 162; Martínez 2018, pp. 102, 223.

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That historians of science have applied the term 'animism' to more than one doctrine in the Renaissance and early modern periods is a fact that has not been sufficiently acknowledged, much less properly analysed.[9] The focus here will be on two kinds of animism regularly identified by historians for these periods: Aristotelian and Platonic. The question of Gilbert's animism thus hangs on the broader question of whether he was an Aristotelian or a Platonist. Answering this broader question turns out to be somewhat less than straightforward.

For the Renaissance and early modern periods, Aristotelianism and Platonism may be usefully treated as lying at opposite ends of a doctrinal spectrum, a spectrum on which each perspective interpenetrates the other to a greater or lesser degree.[10] Hence, a more realistic approach to the question is: "To which end of this spectrum did Gilbert tend?" Here, too, there is a clear majority among historians. A handful see Gilbert as tending toward Platonism.[11] A significantly greater number, however, see him as tending toward Aristotelianism.[12] Yet there is a lack of consensus among this latter group about the *manner* in which Gilbert was an Aristotelian. Jane Oppenheimer says of Gilbert that Aristotle permeates "the whole fabric of his thought," James King claims that Gilbert "does not move far from scholastic philosophy," and John Heilbron tags Gilbert as "a moderate peripatetic" (Oppenheimer 1953, p. 174; King 1959, p. 130; Heilbron 1979, p. 170). In contrast, Gad Freudenthal views Gilbert as a "revolutionary" peripatetic, Marie Boas writes that Gilbert "attacked Aristotelian

9. In respect of the Renaissance and early modern periods, the term 'animism' is an anachronism. The first appearance of the term is usually credited to Edward Burnett Tylor's 1871 book *Primitive Culture* (Tylor 1871).

10. In this paper, I will use 'Platonism' as an umbrella term also to cover Renaissance Neoplatonism. Likewise, for present purposes, the term 'Aristotelianism' will also be used to cover medieval scholasticism and peripatetic philosophy.

11. See: Agassi 1958; Hesse 1960, p. 132; Kelly 1965; Abromitis 1977. Abromitis, on the one hand, argues that Gilbert's "idea of the animation of the earth may well have come from the animation of the rest of the Aristotelian universe" (p. 95). On the other hand, she claims that Platonism is "an important source for Gilbert's animism" (p. 97). Agassi dismisses the "widespread myth of Gilbert's animism" with the claim that Gilbert was a "Pythagorean-Platonist" (p. 240). Kelly recognises strong Aristotelian threads in Gilbert's work, but describes the force animating Gilbert's earth as a "Platonic principle" (p. 62). The following historians, by contrast, draw Gilbert away from Aristotelianism without explicitly pushing him toward Platonism: Baldwin 1985; Gaukroger 2006, p. 367; and Henry 2012. For Baldwin, the Jesuit Niccolò Cabeo "used traditional Aristotelian arguments to refute the Englishman's animism" (p. 157), a claim that still allows for a link between animism and nonstandard Aristotelianism. Henry writes that, although Gilbert's theory "fit in with" Aristotelianism, "Gilbert's animistic approach [...] is entirely magical" (p. 96).

12. See: Zilsel 1941, p. 4; Boas 1951, p. 466; Oppenheimer 1953, p. 466; King 1959, p. 130; Roller 1959, p. 145; Krafft 1970, p. 130; Heilbron 1979, p. 170; Freudenthal 1983, p. 37; Brooke 1991, p. 119. Here, too, Abromitis (1977, pp. 23, 95) equivocates (see note 11).

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doctrines in perceptibly peripatetic style," and John Hedley Brooke says that Gilbert "reproached Aristotle for not going far enough" (Freudenthal 1983, p. 37; Boas 1951, p. 466; Brooke 1991, p. 119). Duane Roller argues that Gilbert "reject[s] the foundations of Aristotelian mechanics, [yet] is held fast in the intellectual straightjacket of the peripatetic vocabulary" (Roller 1959, p. 145). Lois Irene Abromitis, while also ascribing Platonism to Gilbert (see note 11), writes, first, that Gilbert "departed radically and self-consciously from the Aristotelian framework," and, later in her same work, that "Gilbert really has not moved outside the boundaries of Aristotelian philosophy" (Abromitis 1977, pp. 23, 95). Stephen Pumfrey dubs Gilbert "the butt-kicker of Aristotle," yet concludes that Gilbert "owed more than he recognised to Aristotle" (Pumfrey 2002, pp. 179, 129).

The tangled nature of Gilbert's Aristotelianism reflects the period in which he worked. As Craig Martin has shown, early modern Aristotelianism was marked by "plasticity" and a "divergence of positions and schools" (Martin 2014, p. 5; see also Schmitt 1983, and Sgarbi 2017b). A strong thread running through this tangle was the fraught question of Christian piety, as we will see later.

For the present, I wish to slash a narrow path through this hermeneutic thicket and focus exclusively on Gilbert's animism. Gilbert, I argue, was an Aristotelian animist. But what does this mean? In *De magnete*, Gilbert writes that

> all seek in the world a certain universal soul, and declare the whole world to be endowed with a soul. Aristotle held not that the universe is animate, but the heavens only; his elements he made out to be inanimate; but the stars were for him animate. As for us, we find this soul only in the globes and in their homogenic parts, and albeit this soul is not in all globes the same (for that in the sun or in certain stars is much superior to that in other less noble globes). Still in very many globes the souls agree in their powers. (Gilbert [1893] 1958, p. 308)

In this passage, Gilbert acknowledges a widespread belief in the existence of a universal world soul, or *anima mundi*. He then notes Aristotle's departure from this doctrine in favour of a view of the universe as divided into an inanimate terrestrial region and an animate celestial region. Gilbert then radically modifies Aristotle's view in favour of a universe wherein only "globes" and their "homogenic parts" possess a soul. The respective souls of these globes are not the same—the souls of some being superior in power to those of others—but very many globes in Gilbert's universe share much the same kind of power.

Four points can be touched on here. First, Gilbert understands animacy in terms of power, and he takes the source of this power to be a soul, or something like a soul. Earlier in *De magnete*, Gilbert writes that "the power of self-movement seems to betoken a soul, and the supernal bodies [...] are regarded by some as

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animated because that they move with wondrous regularity" (Gilbert [1893] 1958, pp. 109–10). Animacy is a power of self-movement, and this self-movement is marked by regularity. Gilbert thus understands the soul in terms of an internal power that both enables and regulates, or governs, the movement of the body to which it belongs.

Second, Gilbert follows Aristotle in rejecting a universalist conception of soul—an *anima mundi*—and he instead espouses, again following Aristotle, a regionalist conception. This clearly distinguishes Gilbert from Renaissance Platonism. According to Frances Yates, "the *anima mundi* would have been orthodox to many Christian Renaissance Neoplatonists" (Yates 1964, p. 351; see also Copenhaver & Schmitt 1992, p. 288). Some historians nonetheless have tried to lodge Gilbert's animism within this Neoplatonic orthodoxy (King 1959, p. 139; Abromitis 1977, p. 100). But Pumfrey is surely right that Gilbert "did not jump into the Neoplatonic camp, and make the Earth part of their universal soul. His earth has a soul all of its own" (Pumfrey 2002, p. 129).

Third, Gilbert's regionalism is radically different from that of Aristotle. Because Aristotle's Earth was a motionless object at the centre of the universe, there was no need to ascribe to it a soul. It was the self-movement of heavenly bodies—"in fixed, definite, tracks," as Gilbert puts it—that called for such an ascription. For Gilbert, Aristotle's treatment of the Earth as inanimate was intolerable: "I wonder much why the globe of the earth with its effluences should have been by him and his followers condemned and driven into exile and cast out of all the fair order of the glorious universe, as being brute and soulless" (Gilbert [1893] 1958, p. 309). Hence, Gilbert's regionalism includes the Earth as one self-moving globe within a universe populated by many such globes. His is a pluralist conception of soul, a conception that identifies different souls with different, graduated regions of self-government.

This conception crops up in Marke Ridley's 1613 book, *A Short Treatise of Magneticall Bodies and Motions*. Ridley (1560–1624) was an English physician and natural philosopher, strongly influenced by Gilbert (Jones 1961, p. 65; Johnson 1968, p. 237). He opens the first chapter of his book with the following statement:

> That we define to be a *Magneticall body*, which seated in the *aether* or *aire*, doth remaine and place itselfe in one place or kind of situation naturall, not alterable; as all starres do, and the great regent Globes of *Saturne*, *Mars*, *Iupiter*, the *Sunne* and the *Earth* do; or such as with respect and attendance follow other Globes, as [...] the two travelers about the Sunne, called *Venus* and *Mercury*, and lastly the Moone, which doth follow, or go about the Earth, and respecteth the same alwayes with one pole: and therefore hath a peculiar *Magneticall* vertue that guideth her in this kinde of situation. (Ridley 1613, pp. 1–2)

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The editors of the 2009 edition of the *Oxford English Dictionary* chose this passage to support their definition of a now rare adjectival form of "regent" as "ruling, governing, or holding supremacy."[13] Following Gilbert, Ridley takes Saturn, Mars, Jupiter, the Sun, and the Earth to govern their own distinct regions. (Both "regent" and "region" stem from the Latin *regere*, "to rule.") Ridley also follows Gilbert in declining to affirm Copernicus's claim that the Earth revolves around the Sun. Only Mercury and Venus do that, as does the Moon around the Earth. This may be a sign of the reduced sovereignty of these globes in comparison to the Earth, a sign of their being what Gilbert calls "less noble."[14]

The fourth point to touch on is Gilbert's claim that animate power is to be found not just in globes, but also in their respective "homogenic parts." Gilbert's globes, while distinct from one another, are homogenous in respect of their own internal parts. He writes that "the magnetic nature is proper to the earth and is implanted in all its real parts according to a primal and admirable proportion" (Gilbert [1893] 1958, p. 105). For this reason, Gilbert can base his study of the Earth on a study of certain small bits of terrene matter, namely,

13. *Oxford English Dictionary* (online), third edition, published December 2009.

14. Several historians have attributed to Gilbert the Copernican belief that the Earth orbits the Sun (e.g., Jones 1936, p. 20; Freudenthal 1983, pp. 33–4; Pumfrey 2002, p. 93; Miller 2014, p. 66n8). Yet, all but Jones acknowledge that Gilbert never explicitly states this belief. Pumfrey suggests that Gilbert "concealed his position," but then does not plausibly explain why. (On this point, Agassi suggests that "religious scruples" could not have inhibited Gilbert, as the Earth's diurnal rotation was the "greater heresy" (Agassi 1958, p. 237).) Freudenthal recognises that "[f]or Gilbert the geocentric and heliocentric hypotheses were physically (as well as astronomically) indistinguishable," an observation also made by Johnson and, according to Kelly, by William Whewell (Johnson [1937] 1968, pp. 216, 222–24; Kelly 1965, p. 108). Johnson points out that empirical confirmation for this belief came only in 1838 (p. 106). Both Freudenthal and Miller suggest that Gilbert was motivated not by evidence, but by Renaissance Platonism. But I argue here that Gilbert was an Aristotelian. For his part, Jones finds "sufficient evidence" that Gilbert affirmed Copernican heliocentricism in this passage from S. P. Thompson's 1900 translation of *De magnete*: "The Earth, then, which by some great necessity, even by a virtue innate, evident and conspicuous, is turned circularly about the Sun, revolves" (Gilbert 1900, p. 224). The original Latin reads: *Volvitur igitur terra quae magnâ quâdam necessitate, virtute etiam infitâ, manifestâ, & conspicuâ, convertitur ad solem circulariter* [tentatively, "is turned round circularly toward the Sun"] (Gilbert 1600, p. 224). Mottelay's translation seems better: "The earth therefore rotates, and by a certain law of necessity, and by an energy that is innate, manifest, conspicuous, revolves in a circle toward the sun" (Gilbert [1893] 1958, p. 333). Although Gilbert calls the Sun "the mover and inciter of the universe," he also asserts that the "substance of the terrestrial globe withstands and resists universal nature" (Gilbert [1893] 1958, pp. 344, 325). Furthermore, in his never-completed, posthumously published, and largely ignored *De mundo*, Gilbert included a diagram in which, unlike the other planets, the Earth is *not* placed in an orbit around the Sun. Kelly writes that "[t]his full page sketch of the cosmos is a graphic illustration of Gilbert's reluctance to commit himself to the motion either of the Sun around the Earth or the Earth around the Sun" (Kelly 1965, p. 42). The diagram is currently (10.12.2020) accessible at *Wikimedia Commons*: https://commons.wikimedia.org/wiki/File:Demundo.png.

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magnets. A disciplined experimental study of magnetic phenomena at the local level of discrete magnets will also provide an understanding of these same phenomena at the global level of the Earth. Gilbert argues that "every separate fragment of the earth exhibits in indubitable experiments the whole impetus of magnetic matter" (Gilbert [1893] 1958, p. 71; see also p. 27). This specifically terrene "impetus" is a "true magnetic potency which we call the primary energy" (Gilbert [1893] 1958, p. 105). It is an animate power distributed throughout the Earth's globe, or region, and permeating all of its parts.

Hence, when Gilbert runs a magnetic experiment, his goal is to release a magnet from local and contingent constraints so that it will then be free to realise its primary potency or impetus as a constituent part of the Earth's magnetic globe.[15]

> In this manner it is demonstrated: Put the magnetic stone (after you have found the poles) in a round wooden vessel—a bowl or a dish; then put the vessel holding the magnet (like a boat with a sailor in it) in a tub of water or a cistern where it may float freely in the middle without touching the rim, and where the air is not stirred by winds (currents) which might interfere with the natural movement of the stone: there the stone, as if in a boat floating in the middle of an unruffled surface of still water, will straightaway set itself, and the vessel containing it in motion, and will turn in a circle till its south pole shall face north and its north pole, south. (Gilbert [1893] 1958, p. 26)

Once the magnet is allowed to freely turn, it will naturally come into alignment with the Earth's magnetic soul. Hence, Gilbert concludes that "the loadstone possesses the virtue and power of directing itself toward the north and the south (the earth itself co-operating and giving to it that power) according to the conformation of nature, which adjusts the movements of the stone to its true locations" (Gilbert [1893] 1958, p. 26).

One may wonder here where the power finally lies. The magnet has the power to direct itself, but it has this power from the Earth, which in turn co-operates in moving the magnet. Nature, too, is involved, by adjusting the magnet's movements in accordance with its own pattern of organisation. This is, so to speak, a team effort. The animate power by which Gilbert explains the magnet's regulated movement is a distributed power, exercised by more than one party to the action observed: "Whatever in nature moves naturally, the same is impelled by its own forces and by a consentient [i.e., consensual] compact of other bodies" (Gilbert [1893] 1958, p. 322).

15. For an account of the early modern experiment as a disciplined physical method by which an entity is "released" from contingent, local constraints, so that it may then be free to fulfill its own indigenous nature, see Kochan 2017, chp. 6.

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For this reason, Gilbert rejects the received view of magnetism as *attraction*. Indeed, as Pumfrey writes, "[i]f there was one concept that Gilbert wanted to banish, it was attraction" (Pumfrey 2002, p. 123; see also Wang 2016). The problem is that attraction presupposes an active "attractor" and a passive "attractant." All power lies with the attractor, leaving the attractant powerless. In contrast to this asymmetrical model, Gilbert introduces the symmetrical concept of *coition*. He writes: "Coition, we say, not attraction, for the term attraction has wrongfully crept into magnetic philosophy, through the ignorance of the Ancients; for where attraction exists, there, force [*vis*] seems to be brought in and a tyrannical violence rules" (Gilbert [1893] 1958, pp. 97–98; brackets added).[16] For Gilbert, the fundamental relationship between the homogenic parts of the Earth's globe is a nonviolent one, a relationship free from tyranny, a relationship of peace and friendship.

Gilbert tells us that "[t]he parts of the earth, as of all magnetic bodies, are in accord and enjoy neighborhood with each other: there is in them all mutual love, undying good-will" (Gilbert [1893] 1958, p. 147). Coition is present, for example, in the "friendship of iron for the loadstone" (Gilbert [1893] 1958, p. 50). Here, "the magnetic coition is the act of the loadstone and of the iron, not of one of them alone: it is ἐντέλεχεια [*entelecheia*], not ἔργον [*ergon*]" (Gilbert [1893] 1958, p. 110; brackets added).

Ergon means "work," the transfer of energy from one place to another, as when a hockey player slaps a puck into the net, or an artist carves a mask from wood.[17] There is here a clear distinction between the agent and the patient, between the subject and the object of an action. *Entelecheia*, on the other hand, is a word coined by Aristotle using the words *telos*, "end," and *echō*, "to have." It literally means "intrinsic possession of an end," and Aristotle used it as a descriptor for the soul (*psyche* in Greek, *anima* in Latin).[18] Gilbert views magnetic coition as a manifestation of a soul held in common by iron and magnet. Inhabiting the same globe, or "neighbourhood," and based on their "friendship," "mutual love," and "good-will," magnet and iron work together to actualise this shared soul, to realise it as the final end of their collective effort. There is no clear distinction here between agent and patient, subject and object. In grammatical terms, neither the active nor the passive voice captures the meaning. The meaning is reflexive. In

16. The passage continues: "Hence, if we have at any time spoken of magnetic attraction, what we meant was magnetic coition and primary confluence." (See also note 2.)

17. This is an Aristotelian account of artistic production (i.e. *techne*). One might alternatively emphasise the wood's active role: "a true cabinetmaker [...] makes himself answer and respond above all to the different kinds of wood and to the shapes slumbering within wood" (Heidegger [1954] 1968, p. 14).

18. Cf. Hugh Lawson-Tancred's introduction to his translation of Aristotle's *De Anima (On the Soul)* (Aristotle 1986, p. 119).

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magnetic coition, magnet and iron work on themselves, on one another, together as a unit or team. They do this as homogenic parts of a magnetic Earth.

We have now seen that one key difference between Aristotelian and Platonic animism is a difference between regionalist and universalist conceptions of soul, where the soul is thought in both cases to provide a power of self-movement and self-regulation. Gilbert's animism is regionalist, and, therefore, Aristotelian. Indeed, he explicitly adopts Aristotle's term *entelecheia* to describe the magnetic soul. This term is a teleological one. It ascribes to the soul an end-directedness, a final cause or regulative principle that lends consistent shape to magnetic activity. Platonic animism is likewise teleological, but also universalist. As we will see in the next section, a key difference in the respective teleologies of Aristotelian and Platonic animism is a difference in the *location* of the regulative power, the final cause or end, which gives shape and direction to natural processes. For the Aristotelian, this final cause is *internal* to the natural phenomenon it shapes. For the Platonist, it is *external* to that phenomenon. In this case, too, Gilbert was clearly an Aristotelian.

3. Non-Deliberative Self-Government in Gilbert's Aristotelian Animism

"[A] doctor doctoring himself: nature is like that." So wrote Aristotle at *Physics* 2:9 $199^{b}30$ (Aristotle 1941b, p. 251). Here nature is taken to operate simultaneously as both agent and patient. As with Gilbert's concept of coition, the regulated activity being described is a reflexive one. In Aristotelian terms, magnetic power is a regional subset of nature's more general power of self-government.

The analogy that Aristotle draws between nature and a physician may raise a worry. One normally thinks of a physician as a deliberative agent. Is Aristotle suggesting that nature is also a deliberative agent? The answer is no, but for reasons that are not straightforward. In this section, we will first review Aristotle's account of nature as self-regulating, but non-deliberative. On this account, one ascribes end-directed behaviour to nature without also ascribing to it a capacity for deliberation. We will then see that this Aristotelian account is compatible with Gilbert's own claim that magnetism is a teleological phenomenon, and that this affirmation of natural teleology does not commit Gilbert to the further claim that magnets orient themselves through thoughtful deliberation. The non-deliberativeness of nature is another characteristic of Aristotelian animism that can also be found in Gilbert.

In the same passage of the *Physics* just cited, Aristotle also writes: "It is absurd to suppose that purpose is not present because we do not observe the agent deliberating. Art [*techne*] does not deliberate" (Aristotle 1941b, p. 251 [$199^{b}26$-27]). Yet Aristotle's claim that art does not deliberate is something that we may likewise find absurd. Surely a physician—as a practitioner of medical art—deliberates?

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In his notes to the *Physics*, C. D. C. Reeve observes that Aristotle's claim that art does not deliberate is an "overstatement of a view expressed more cautiously" in the *Ethics* (Aristotle 2018: 239). There, Aristotle writes that "[w]e deliberate not about ends but about means. For a doctor does not deliberate whether he shall heal" (Aristotle 1941c, p. 970 [1112^{b}13-14]). Where the correct treatment is unclear, the physician will need to deliberate. Where precise rules exist, on the other hand, she will not need to deliberate (Aristotle 1941c, p. 969 [1112^{b}1-5]). When Aristotle writes that nature is like a physician treating herself, he has in mind those cases where the goal—health—is clear, and the path to that goal—the treatment—is routine. In such cases the physician need not deliberate: she simply acts, without giving it a thought.

Furthermore, when a physician doctors herself, the goal of her actions—health—is internal to the patient on whom she acts—namely, herself. This case can thus be distinguished from more conventional instances of art. For example, when an artist carves a mask from wood, the goal—or final cause—of the activity is internal to the artist, and external to the wood. Unlike in the case of a self-treating physician, there is here a clear distinction between agent and patient. Aristotle sometimes also gives the example of a shipwright who follows a plan external to the wood that she uses to build a boat. Yet he also argues: "If the ship-building art were in the wood, it would produce the same results *by nature*" (Aristotle 1941b, p. 251 [199^{b}28-29]). Strictly understood, then, when the goal is internal to the entity in which, or in whom, that goal is being realised, then we have an instance of becoming not by art, but by nature.

In the first pages of *De magnete*, Gilbert announces that he has—by "labors and experiments tested"—successfully disclosed the "nature" of the magnet (Gilbert [1893] 1958, p. 14). As we have seen, he describes this magnetic nature in terms of the magnet's "power of directing itself" (Gilbert [1893] 1958, p. 26). It is, in other words, an internal teleological power, an instance of *entelecheia* rather than of *ergon*. Near the end of the book, Gilbert furthermore concludes that magnetic motions "are not produced by thoughts or reasonings or conjectures, like human acts, [...] but connate in them are reason, knowledge, science, judgment, whence proceed acts positive and definite from the very foundations and beginnings of the world" (Gilbert [1893] 1958, p. 311). This echoes Aristotle's claim that nature, like art, does not deliberate. The magnet non-deliberatively directs itself by nature in a way similar to a physician who, having a clear concept of health and an established procedure, cures herself by art, also without deliberation. In both cases, the final cause is internal to the entity who is, or that is, in the process of realising it.

But this internal teleological power has a different provenance in each case. For Gilbert, as we have just seen, the magnet's innate power is "definite

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from the very foundations and beginnings of the world." In the case of the human actor, things are otherwise. Gilbert writes:

> The human soul uses reason, sees many things, investigates many more; but, however well equipped, it gets light and the beginnings of knowledge from the outer senses, as from beyond a barrier—hence the very many ignorances and foolishnesses whereby our judgments and our life-actions are confused, so that few or none do rightly and duly order their acts. (Gilbert [1893] 1958, p. 311)

Like Aristotle, Gilbert subscribes to the empiricist belief that human beings apply reason to sense perception in order to acquire knowledge. This is a less than perfect epistemic procedure and it often results in error. Only through careful, stepwise deliberation might a physician develop reliable knowledge of the means to health.

Not so with magnets. They acquire knowledge, or something like knowledge, neither through the senses nor through deliberative reasoning. Their "knowledge" is innate, fully formed and definite from the start. Gilbert writes that "the earth's magnetic force and the formate soul or animate form of the globes [...] are without senses, but without error." As a consequence, the magnet's actions are flawlessly "quick, definite, constant, directive"; they are invariably "calculable, definite, constant, comparable to the movements of the stars" (Gilbert [1893] 1958, pp. 311, 102). Magnets do not calculate when they act, but their actions are amenable to calculation. Nor do they rationally deliberate when they act, but their actions invite deliberative, rational analysis.

This brings us to another key difference between the Aristotelian and Platonic accounts of animism. Gilbert describes magnetic power in terms of a "formate soul or animate form." For Platonists, form can be separated from body. For Aristotelians, in contrast, form cannot be separated from body. Gilbert's construal of the magnetic soul in terms of form agrees with the Aristotelian position that form is inseparable from body (Pumfrey 2002, p. 52). In other words, the innate and non-deliberative directive power that Gilbert takes to animate the magnet is also, for him, a power that cannot exist in the absence of the magnet's physical body:

> We do not mean that the magnetic forms and spheres exist in the air, or water, or any other medium not magnetical, as though the air or water took them on or were by them informated; for the forms are only effused and really subsist when magnetic bodies are present. (Gilbert [1893] 1958, p. 305)

Furthermore, in addition to the existential contingency of magnetic form on the presence of body, Gilbert argues that this form is "effused," or extends,

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beyond the physical surface of the body. A magnet's sphere of influence thus encompasses a space greater than that occupied by its own physical body, and that sphere can exist only as long as the body itself exists:

> For such is the property of magnetic spheres that their force is poured forth and diffused beyond their superficies spherically, the form being exalted above the bounds of the corporeal nature. (Gilbert [1893] 1958, p. 304)

Hence, Gilbert's experimental study of magnets leads him away from the notion that natural motion requires physical contact between bodies. He therewith adopts an idea that later advocates of the mechanical philosophy would reject as "action at a distance":

> [I]n the several spheres magnetic bodies control other bodies magnetical and excite them even as though the spheres of influence were solid materiate loadstones; for the magnetic force does not proceed through the whole of the medium, nor exists really as in a continuous body; and so the spheres are magnetical, and yet are not real spheres existing by themselves. (Gilbert [1893] 1958, p. 305)

A few pages later, Gilbert once again emphasises that magnetic power is internal to, and also originates from within, the physical body of the magnet itself: "the agent force abides in bodies themselves, not in space, not in the interspaces" (Gilbert [1893] 1958, p. 322). When magnet and iron mutually affect one another, or when two magnets orient themselves toward one another, they may do so across empty space, that is, at a distance.[19] On this model of magnetism, it is not necessary to provide a mechanical explanation of magnetic power in terms of microscopic particles that invisibly travel across the space separating two visible bodies.

19. Xiaona Wang, in what Henry endorses as a challenge to the prevailing view, argues that Gilbert did not believe in action at a distance (Henry 2019, p. 31n5; see also note 3). Her argument appears to hinge on Gilbert's statement that "no action can be performed by matter save by contact" (Gilbert [1893] 1958, p. 92; see Wang 2016, p. 710). If I have understood her argument correctly, Wang infers from this that Gilbert must have reduced action to *material* action. Hence, since for Gilbert "magnets did not work by material means," Wang concludes that, for him, magnets could not act at a distance: "Gilbert was able to deny action at a distance between magnets by suggesting that there was no physical force operating between them at all!" (Wang 2016, pp. 711, 712). Yet Gilbert's belief that no action can be performed by matter save by contact is consistent with a belief that action may be performed by an immaterial or non-physical entity (a "formate soul or animate form") without contact, that is, at a distance. Note that Hesse cites the same passage on which Wang hinges her argument, likewise affirms that, for Gilbert, magnetism is not a material phenomenon, and yet concludes that the operation of magnetic form "Gilbert regards as a true action at a distance" (Hesse 1960, pp. 88–89, 90, 91).

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To sum up, Gilbert was an Aristotelian animist. This fact has not received sufficient attention from historians of science, who have often painted animism in Platonic terms. Platonic animism is generally marked by a belief in a universal soul, an *anima mundi*. Platonists furthermore believed the soul to be separable from, and hence able to exist independently of, the material body it was thought to govern. The Platonic *anima mundi*, then, is both universal and separable from body. This soul is furthermore distinguished by its rational or intellective powers.

Gilbert's Aristotelian animism, in contrast, rejects *anima mundi* for a pluralist conception of soul that attributes different kinds of soul to different regions of natural activity. This Aristotelian animism is also hylomorphic, taking natural substances to be composed of mutually dependent matter (*hyle*) and form (*morphe*). As form, soul is not separable from body, but depends on it for its own existence. As a necessary and inseparable constituent of a living body, Aristotelian soul is internal to that body, governing it from within. Finally, this soul can operate without rational deliberation, though its operations may still be amenable to rational analysis. All four of these characteristics—pluralistic regionalism, inseparability from body, immanence in the natural realm, and non-deliberative action—can be found in Gilbert's conception of the magnet soul as *entelecheia*. Hence Gilbert is best viewed as an Aristotelian animist.[20]

4. Unwitting Animism in Robert Boyle's Natural Philosophy

We saw in the Introduction that mechanical explanations were thought by Aristotelians to have their limits. Like ancient atomism, Gassendi's mechanical philosophy could not explain the directedness of natural motion in natural philosophical terms. But that was largely the point. By rejecting a role for teleology in natural philosophy, Gassendi ensured that final causation would be conceptualised as something wholly external to nature. The power that governs natural movements is, on this mechanical account, a separate, supernatural power. As a consequence, teleology becomes a topic proper to theology rather than to natural philosophy. The introduction of mechanism was meant to defuse the perceived threat to Christian piety posed by natural teleology.

This rejection of natural teleology, in general, also meant a rejection of animism, in particular. Recall from the Introduction that animism is a special case of natural teleology, a special instance where a teleological power of self-government is located not just in the natural realm, as such, but more specifically in the particular natural body that is thought to direct its own movements.

But did the new mechanical philosophy really succeed in removing natural teleology and animism from natural philosophy? Several historians have argued

20. A more detailed account of the dynamic tension between Aristotelian and Platonic conceptions of soul during the medieval and Renaissance periods, also in relation to animism and natural teleology, may be found in Kochan (forthcoming).

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that, despite his claims to the contrary, teleological undercurrents flowed implicitly back into Gassendi's mechanical philosophy. Recall Koyré and Osler's observations that Gassendi assigned to his microscopic particles a natural directedness or function that his mechanical philosophy was unable to explain. The immanent power of self-government that Gilbert had self-consciously included in his own magnetic philosophy was now something that Gassendi unwittingly allowed to circulate, without conceptual license, through his allegedly more Christian mechanical philosophy.

The same may also be observed a generation later in the mechanical philosophy of Robert Boyle. Like Gassendi, Boyle combined his advocacy for mechanism with a defence of Christian piety. In his 1662 treatise, *A Defence of the Doctrine Touching the Weight and Spring of the Air*, Boyle writes: "I am not very forward to allow acting for ends to bodies inanimate, and consequently devoid of knowledge" (Boyle 2000a, p. 40; see also Boyle 2000b, p. 114). In a later work, *A Free Enquiry into the Vulgarly Received Notion of Nature*, Boyle furthermore "demand[s] whether those I reason with believe nature, though corporeal, to act knowingly—i.e. with consciousness of what she does and for predesigned ends" (Boyle 1996, p. 145). Boyle goes on in the *Free Enquiry* to explain why he hesitates to ascribe knowledge to "bodies inanimate": "it is a dangerous thing to believe other creatures than angels and men to be Intelligent and rational, especially to ascribe to any of them an architectonick, provident and governing power." Why did Boyle consider this dangerous? Because, he says, "I think it dangerous to religion in general and, consequently, to the Christian. For this erroneous conceit defrauds the true God of divers acts of veneration and gratitude that are due to him from men" (Boyle 1996, pp. 57, 62). As Laurence Carlin and Timothy Shanahan have both argued, Boyle rejected natural teleology on theological rather than on natural philosophical grounds (Shanahan 1994, p. 190; Carlin 2011, p. 672; see also Potter 2001, p. 124ff.).[21]

It should be immediately clear that Boyle's theologically infused criticism of natural teleology, when directed at Gilbert's Aristotelian animism, flies wide of the mark. We have seen that, while Gilbert does indeed assign ends to magnets, he does not attribute rationality to them. For Gilbert, their "knowledge," such as it was, is of a thoroughly non-deliberative character. Yet he still sees evidence in magnets for a rationally tractable *entelecheia*, an internal governing power.

As with Gassendi, Boyle's theological rejection of natural teleology sat uncomfortably with his natural philosophical practice. Several historians have observed that Boyle, like Gassendi, could not stem an undercurrent

21. On the theological aspects of seventeenth-century mechanical philosophy, see Fisch 1953, Schaffer 1986, and Ben-Chaim 2002. Amos Funkenstein observes that "to many seventeenth-century thinkers, theology and science merged into one idiom, part of a veritable secular theology" (Funkenstein 1986, p. ix).

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of animism from running back into his mechanical philosophy (Henry 1986; Clericuzio 1990; Osler 2001b; Anstey 2002). Osler argues that "Boyle [...] appealed to immanent finality, albeit unwittingly and contrary to his own stated intentions," and that natural teleology is "evident in the details of Boyle's theory of matter" (Osler 2001b, pp. 166, 164). She gives as an example Boyle's "spring of the air." In Experiment 1 of his 1661 *New Experiments Physico-Mechanical*, Boyle explains the air's spring in these terms:

> [O]ur Air either consists of, or at least abounds with, parts of such a nature, that in case they be bent or compress'd by the weight of the incumbent part of the Atmosphere, or by any other Body, they do endeavour, as much as in them lies, to free themselves from that pressure, by bearing against the contiguous Bodies that keep them bent. [...] For though these Haires [of wool], and the Aerial Corpuscles to which we liken them, do easily yield to externall pressures; yet each of them (by vertue of its structure) is endow'd with a Power or Principle of self-Dilation. [...] [W]hilst the compression lasts, there is in the fleece they compose an endeavour outwards. (Boyle 2000c, p. 165)

Here Boyle attributes to air corpuscles a "power" of self-dilation, an "endeavour outward." He argues that, being "of such a nature," an air corpuscle can direct itself outward "by vertue of its structure." Picking up on this, Osler rightly observes that Boyle "left unanswered the question of how that structure could produce a seemingly goal-directed process" (Osler 2001b, p. 166). This recalls Koyré's criticism of Gassendi's mechanical account, already cited in the Introduction: "[These] little strings, little chains, hooks, the actions of particles, [...] are quite unable to do the job that Gassendi assigns to them" (Koyré 1978, p. 248). As we have also seen, Osler furthermore argues that the activity attributed to these little strings and hooks "goes beyond the bounds of purely mechanical principles" (Osler 2001a, p. 434). For this reason, she concludes that Gassendi, "perhaps unwittingly," "introduced elements of animism into his atomism" (Osler 2001a, p. 439; Osler 2000, p. 203). It appears that Boyle, for similar reasons, also introduced elements of animism into his natural philosophy.[22]

Boyle would surely not have viewed this as a slide back into animism, because he understood animism to be a doctrine that ascribes a rational faculty to inanimate beings. But, again, this definition fails to capture the Aristotelian animism deployed by Gilbert. As a consequence, Boyle not so much refutes Gilbert's animism as he fails to recognise it as one possible means for explaining regularity in nature. But what made possible Boyle's failure to understand

22. For a defense of Boyle against Osler's interpretation, see Carlin (2012). For a response to Carlin that reaffirms Boyle's residual animism, see Kochan (forthcoming). This latter paper also gives a fuller account of Boyle's residual animism.

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Gilbert's kind of animism? Put briefly, it was Boyle's conflation of Aristotelian animism with Platonic animism.

Earlier, we noted Koyré's comment that Gassendi, instead of directly addressing the question that magnetism posed to his mechanical philosophy, reframed the question such that solutions like Gilbert's were excluded from consideration. For Gassendi, as for Boyle, magnetic power was necessarily *external* to the natural realm as such. Hence Gilbert's belief in a telic power immanent in magnetic bodies themselves—the basis for his magnetic animism—was ruled out of the natural philosophical court. Moreover, in Boyle's case, the idea of a non-deliberative governing power immanent in the natural realm was also excluded from consideration. As Osler observes, Boyle "used only one aspect of Aristotelian final cause – ends ascribed to intelligent agents – and ostensibly ruled out the other kind of final cause that ascribed immanent finality to things in the world" (Osler 2001b, p. 164). Hence, for Boyle, the kind of telic power represented by Gilbert's magnetic *entelecheia* was now treated both as being rational and as being external to a natural realm evacuated of self-government.

Boyle was apparently unable to recognise that an appeal to animism of the sort made by Gilbert could still be an option for natural philosophy. Instead, when confronted with this option, he mistook it for the impious ascription of rational thought to nature. As Anstey argues, "scholastic descriptions of vegetative and sensitive functions of animate creatures in terms of functions of the soul now seemed to Boyle to smack of attributing thought to matter" (Anstey 2001, p. 498). One imagines that Boyle would have likewise mistaken Gilbert's ascription of non-deliberative functions to magnetic soul as the errant attribution of thought to matter.

Recall that Gilbert attributes the magnet's inherent power of self-government to its "formate soul" or "animate form." He thus follows the scholastic Aristotelian tradition of elaborating at least some faculties of the soul in terms of what was called "substantial form." Indeed, as Don Garrett has pointed out, scholastic Aristotelians developed the theory of substantial form "in response to the felt need to provide an unthinking teleological selection *process* in individual substances" (Garrett 1999, p. 326).[23] In opposition to this, Christian Platonists of the Renaissance sought instead to eliminate all form that was contingent on matter. For them, if form is to inhere in a substance, then that substance must itself be separable from body. Nevertheless, as Katherine Park has argued, the Aristotelian notion of an "organic soul"—"the principle responsible for those life functions inextricably tied to the bodies of living things"—enjoyed "a new autonomy and general prominence" from the middle of the sixteenth century

23. For his part, Edgar Zilsel argues that the "Aristotelian substantial forms of scholasticism are but rationalizations of prescientific, magic, and animistic teleology" (Zilsel [1942] 2001, p. 939).

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onwards, that is, the same period in which Gilbert began his study of magnetism (Park 1988, pp. 464, 483; see also Casini 2007, p. 150). But this was, in the final act, a minority position. The momentum lay behind those Renaissance Platonists who restricted the soul to its intellective functions, which they viewed as separable from matter and, therefore, potentially immortal. The material contingency of the organic soul was, for them, "un-Christian and incompatible with the dictates of reason" (Park 1988, p. 483; see also Kochan forthcoming).

It looks like Gilbert hitched his natural philosophy to this minority Renaissance position, and so modelled his idea of a *sui generis* magnetic soul on the extant Aristotelian idea of a non-deliberative and materially contingent organic soul. This was not a fortuitous choice. *De magnete* appeared on the crest of a minor Aristotelian wave that would soon crash on the shoals of an insurgent mechanical philosophy. Both Henry and Osler have observed that mechanical philosophers worked assiduously to remove Aristotelian substantial forms from the explanatory toolbox of early modern natural philosophy (Henry 1997, p. 69; Osler 2001b, p. 154). For Boyle, much as for Renaissance Platonists, the material contingency of substantial forms threatened Christian piety, especially the doctrine of an immortal soul (Martin 2014, p. 157).

Yet, as we have seen, Boyle mistook a belief in the material contingency of substantial forms for the ostensibly absurd belief that matter can think, that is, that material entities possess an intellective or deliberative soul. In *Free Enquiry*, Boyle explicitly associates this latter belief with the Platonist concept of *anima mundi* when he criticises those "unbelievers who admit of a soul of the world or spirits in the stars or, in a word, think the universe to be governed by intellectual beings distinct from the supreme being we call God" (Boyle 1996, p. 14). He then proceeds, on the one hand, to assert a "great affinity between the soul of the world [...] and the thing that men call nature," and, on the other hand, to attribute to his opponents a belief that "the principle called nature is a substance" (Boyle 1996, pp. 47, 143). Clearly within his sights is the Platonist doctrine of *anima mundi* as an intellectual substance separable from matter. But Gilbert's Aristotelian notion of the magnetic soul, as the non-deliberative, formal aspect of a substance that must also include a material part, is left untouched by this criticism.

Dennis Des Chene has argued that "[t]he demise of substantial forms has led philosophers to conflate what for the Aristotelians are distinct positions: their own, and the Platonists'" (Des Chene 2000, p. 72). According to Des Chene, philosophers today "typically do not distinguish between complete and incomplete substances," and so conflate the Aristotelian account of the soul as an incomplete substance with a now unfashionable mind-body "substance dualism" (Des Chene 2000, p. 72). Remarkably, Des Chene concludes from this that, in respect of the Aristotelian account, "[j]ibes about animism or the ghost in the machine, therefore, miss their target" (Des Chene 2000,

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p. 79). This identification of animism with substance dualism is itself an unfortunate conflation of Aristotelian with Platonic animism.

Dmitri Levitin has recently shown that this conflation was, in significant part, a consequence of Gassendi's attribution to Aristotle of the Platonic doctrine of *anima mundi*: "There was *one* major contemporary philosopher who sought to portray Aristotle as a believer in an *anima mundi*: Pierre Gassendi" (Levitin 2014, p. 177). Levitin furthermore argues that "Gassendi [...] had suggested that virtually all the Greek philosophers had been animists," and that "Boyle was almost certainly influenced by Gassendi's radical rewriting of the history of Greek philosophy" (Levitin 2015, p. 24; Levitin 2014, p. 178). Hence, Boyle was led to mistake an Aristotelian hylomorphic animism for the espousal by Platonic animists of an *anima mundi*: "Boyle argued that not only well-known animists like Plato and the Stoics but even Aristotle himself had held an idolatrous view of nature that placed an intermediate principle such as an *anima mundi* between God and the world" (Levitin 2015, p. 398). While both types of animism posed a threat to Christian piety, only the Platonic type was recognised by Boyle and so directly addressed with argument.

Although Des Chene's criticism is aimed at present-day philosophers, Levitin's work shows that it may also find traction against Boyle. Already in the late seventeenth century, philosophers found it difficult to grasp Renaissance Aristotelianism on its own terms, and so they instead ended up conflating it with more familiar—or, perhaps, more conveniently absurd—positions.[24] By failing to properly grasp the Aristotelianism that they wished to overcome, early modern natural philosophers like Gassendi and Boyle were left unprotected against the undercurrents of Aristotelian animism that continued to circulate through their own accounts of nature.

One might think that this was all for the good. In a passage from *Free Enquiry*, Boyle draws a striking analogy between activity in nature and human activity, an analogy with which Aristotle may have found much to agree:

> [W]e may conceive that though nature be admitted to be endowed with reason, yet a multitude of phenomena may be mechanically produced without her immediate intervention; as we see that in man, though the rational soul has so narrow a province to take care of as the human body and is supposed to be intimately united to all the parts of it, yet an abundance of things are done in the body by the mechanism of it without being produced by that soul. (Boyle 1996, pp. 143–44)

24. Steven Shapin writes that "[i]t was these teleological and animistic features of the traditional physics that the new natural philosophers of the seventeenth century seized on—indeed, caricatured—as marks of its absurdity and *unintelligibility* (Shapin 1996, p. 30). I hope to have shown here that these caricatures may often have been unwitting rather than intentional.

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Gilbert might have replaced "mechanically" with "magnetically" in this passage, and then agreed with Boyle that there are a multitude of natural phenomena that are produced non-deliberatively, that is, without the intervention of reason. He might have then pointed out—just as several historians have done today—that Boyle's mechanical explanations of natural phenomena often make tacit, unacknowledged use of the same sort of teleological principles that Gilbert himself had spelled out explicitly in his animistic doctrine of magnetic *entelecheia*. No doubt Boyle the Christian moralist would have been appalled by this criticism. But he may also have felt an uncomfortable disjunction opening up between his pious self and the careful empirical practice of another Boyle, the disciplined natural philosopher. As Anstey has rightly observed: "Boyle was unable to resolve this dilemma in his natural philosophy" (Anstey 2002, p. 628). For Gilbert, in contrast, no such dilemma existed.

5. Conclusion: Political Expediency and Illusion in Early Modern Science

I have sought in this paper to strengthen a claim previously made by John Henry that "Gilbert's animism and empiricism were entirely complementary" (Henry 2001, p. 117). As we have seen, Gilbert's Aristotelian animism fit nicely with his use of disciplined physical experiments. Yet it would be a mistake to conclude that Gilbert inferred the existence of an internal and regional magnetic form from his experiments alone. His was not the pure observation of a radical empiricist, one who seeks to apply a mind swept clean of background assumptions. As Mary Hesse has observed, "Gilbert's theories determine throughout the interpretations he makes of his experiments" (Hesse 1960, p. 130). Though I am wary of Hesse's term "determines," it is true that Gilbert relied on animistic ideas when interpreting his experimental data. Hesse also notes that, when compared to the more radical empiricism of his close contemporary, Francis Bacon, "Gilbert's hypothetical method is nearer the pattern of later physics, for the empty mind is an illusion" (Hesse 1960, p. 130; see also Johnson 1968, p. 173).

Henry, having established the complementarity of Gilbert's animism and empiricism, furthermore claims that there followed after Gilbert an "extreme divergence of experimentalism and animism in western culture" (Henry 2001, p. 117). This claim I have sought here to weaken. The question of whether or not animism was expunged from experimental practice in the decades following Gilbert is, at least, a matter of ongoing debate. As we have seen, there is evidence that undercurrents of animism still circulated, for example, through Robert Boyle's experimental practice. This unacknowledged animism was in tension with Boyle's mechanical and theological hypotheses. If there was an extreme divergence of animism and experimentalism in the early modern period, then this was, perhaps, a divergence above all in rhetoric. The prevailing mechanical and theological hypotheses of the time insisted on an

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interpretation of natural regularity as being the effect of a cause that was both external and universal. Arguably, the ascendency of these hypotheses was enabled by the growing influence of a Platonised Christianity (Kochan forthcoming). To assert that the apparent self-government of natural phenomena is, in fact, the result of the will or power of a single, supernatural, omnipotent and omniscient deity, was to demonstrate one's public credibility as an appropriately pious, and so politically innocuous, natural philosopher.

This may shed some additional light on Jim Bennett's observation, cited in the Introduction, that, "[a]lthough the Royal Society later adopted Francis Bacon as official methodologist, natural philosophers in the first half of the century were more likely to look back to Gilbert as the founder of the experimental method" (Bennett 1981, p. 166). While Gilbert's method was initially more useful in technical terms, Bacon's method offered later natural philosophers a better advertisement for the public credibility of their new science. For though the empty mind is an illusion, such an illusion may still prove politically expedient.

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